



Monitoring – Why is it important and what is needed?

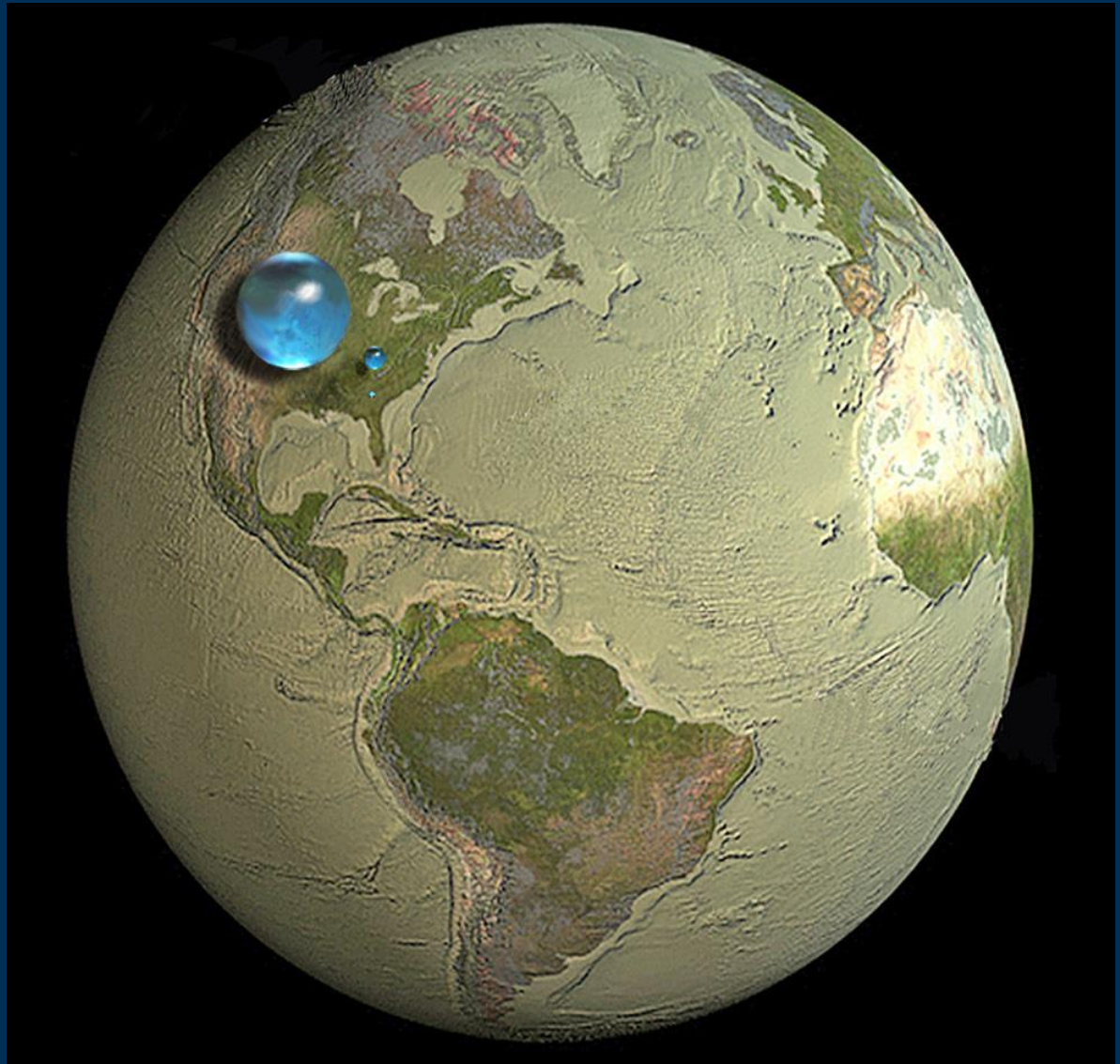
Kentucky Water Resources Board
August 29, 2016

Water – what are we working with?

All water on earth –
volume = ~332,500,000
cubic miles (mi³)

All liquid fresh water
(over KY) - ~170 mi
across or ~2,551,100 mi³

**All water in lakes and
rivers** (over GA) - ~ 35 mi
across or ~22,339 mi³

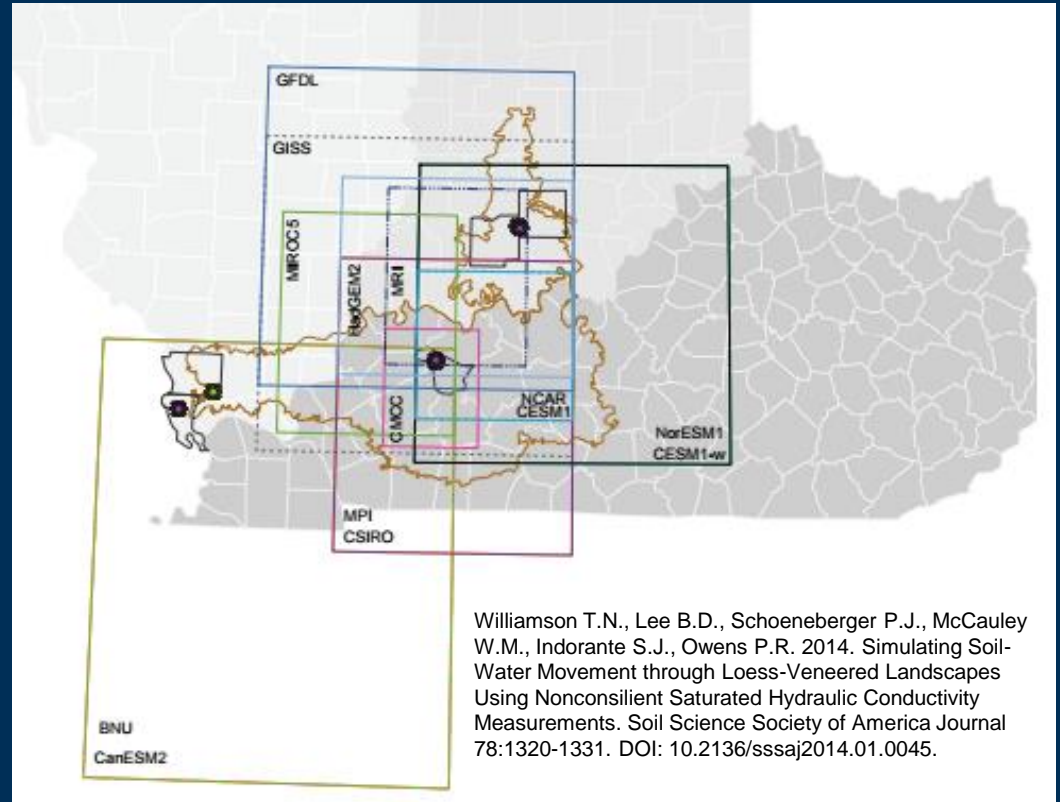


We've heard about
water-use, so
lets look down the
road...

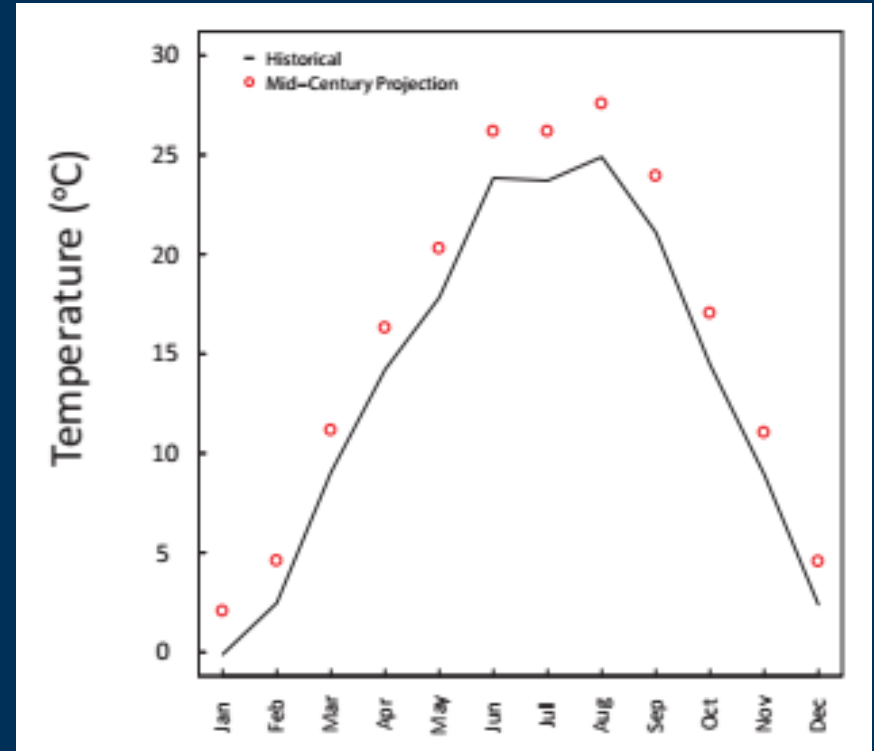
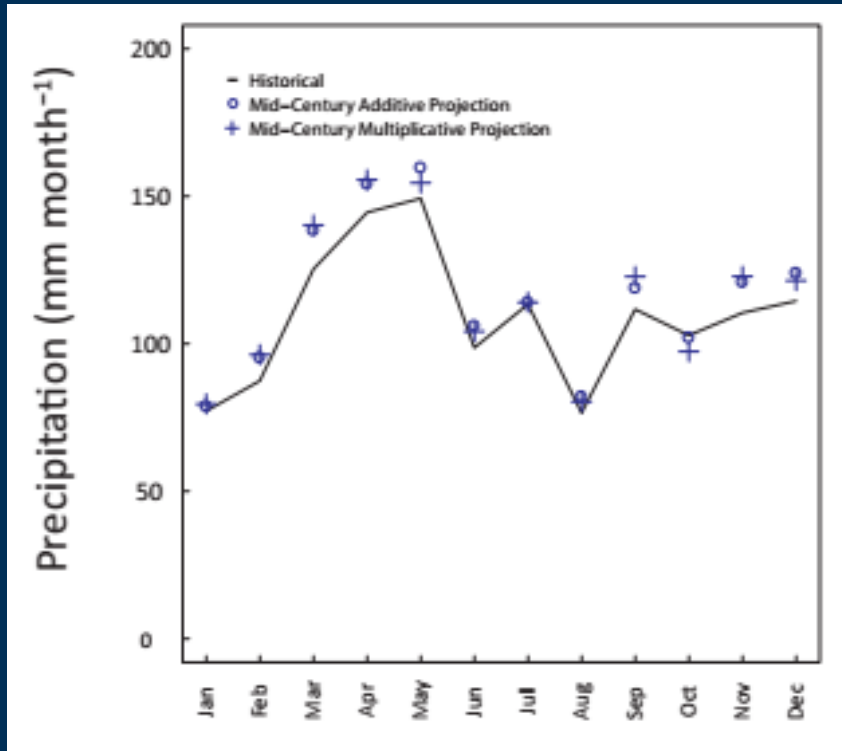
Lets first look at some KY information

Projected Climate Changes at the Shawnee Hills Sites and Incorporation with Simulation of Soil-Water Storage

Work conducted in by USGS, UK, NRCS, and Purdue using the **WATER** application developed by USGS and KDOW.



What does the data show?

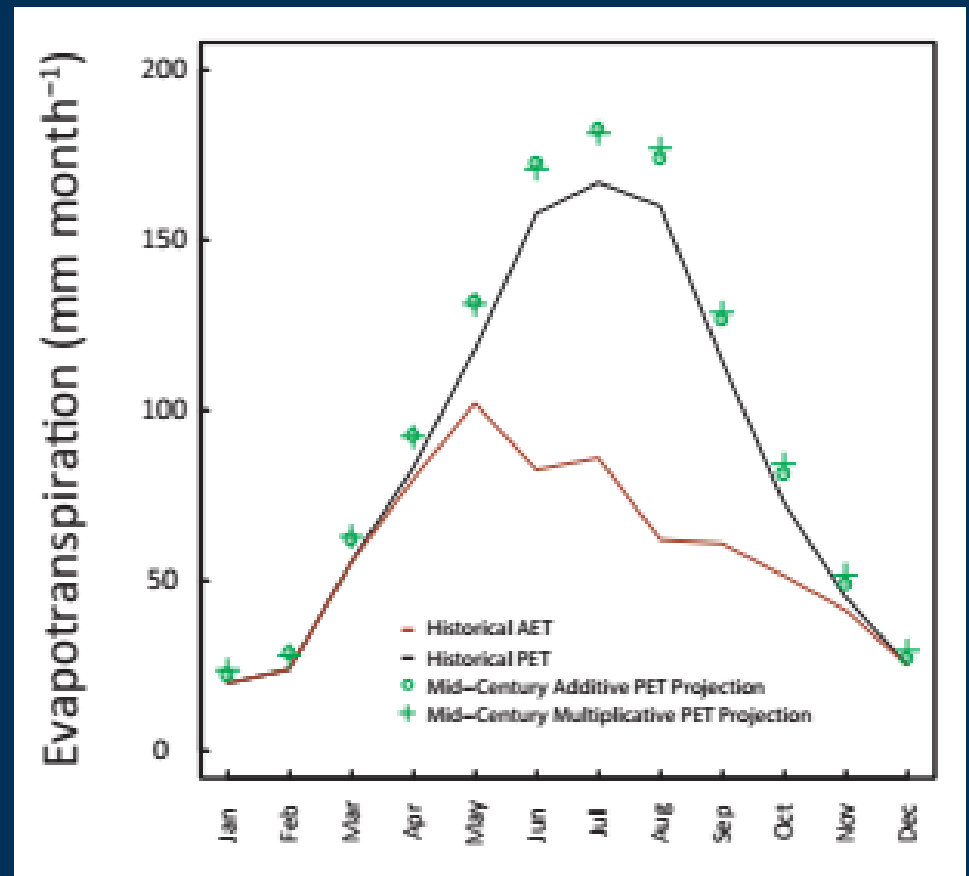


A longer growing season and more rain - but precipitation will likely occur largely in the winter.

What does that mean to KY (especially agriculture)?

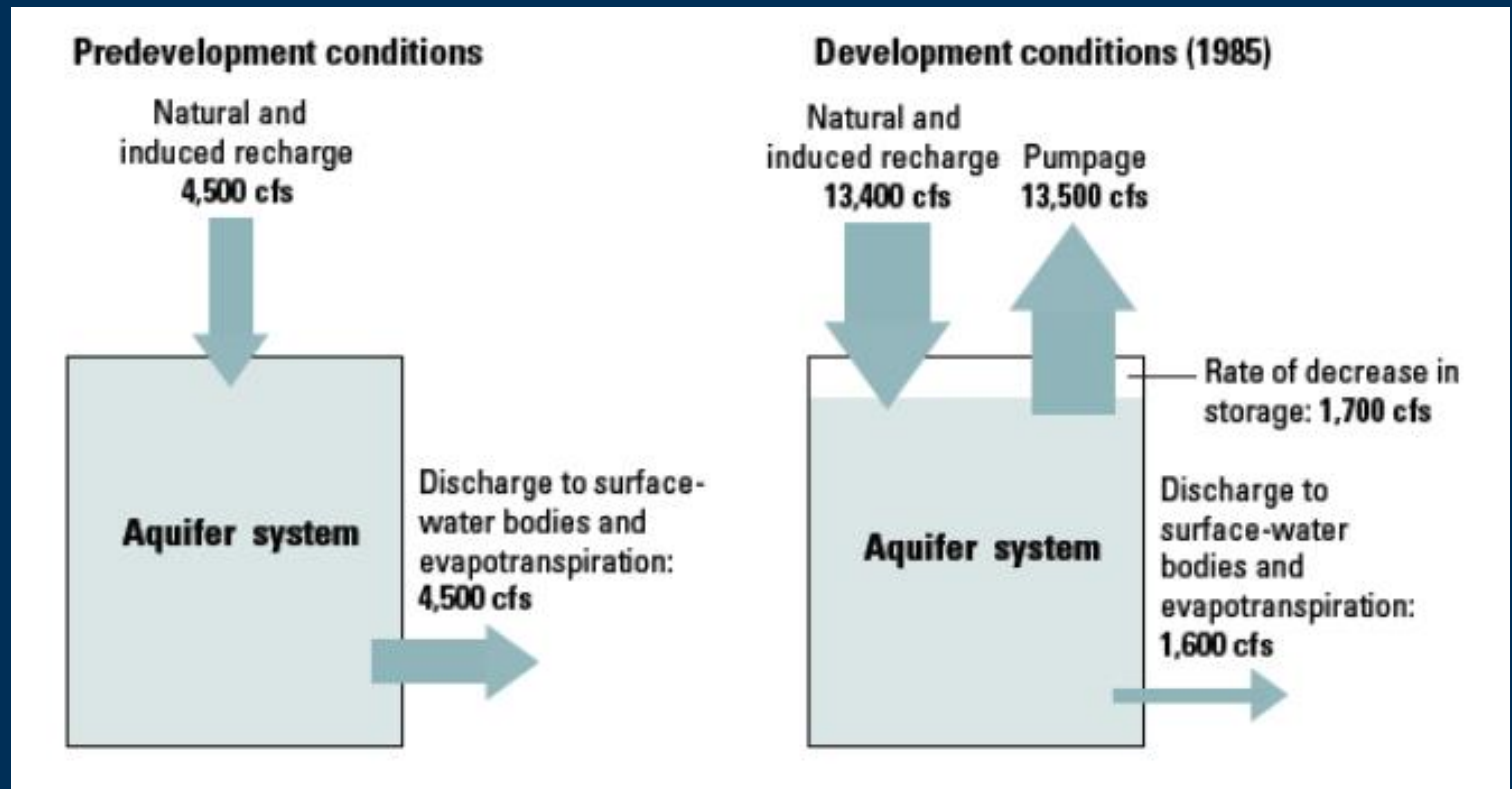
Increased demand (potential evapotranspiration) in times when the system is historically water limited (actual evapotranspiration).

This would indicate that irrigation will likely be of greater importance and the ability to quantify / manage local water resources will be more critical.

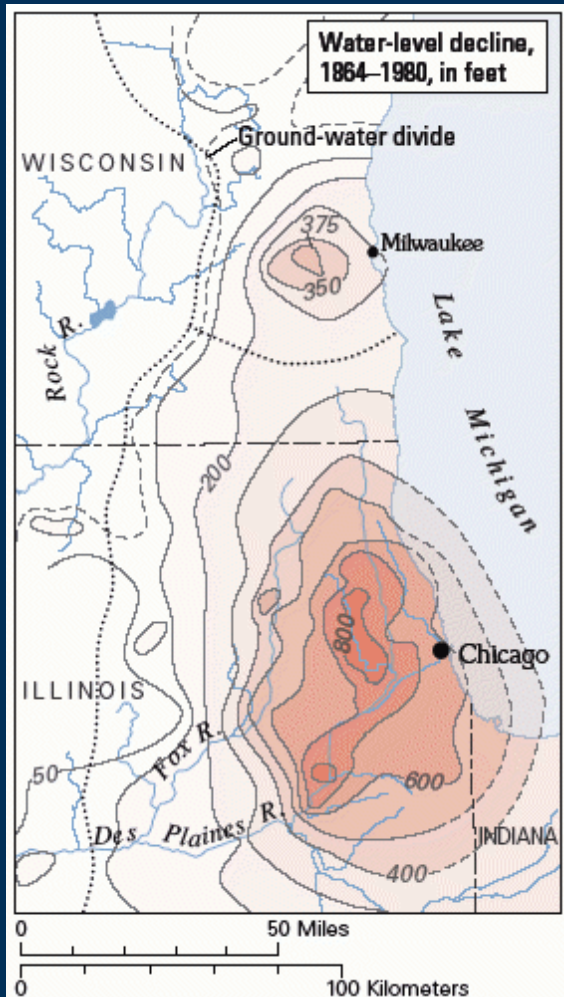


As we develop our water resources...

Plot shows groundwater budgets before and after development of the Gulf Coastal Plain aquifer system. The withdrawals from the aquifers have been balanced by increases in recharge to the aquifer system and decreases in storage and discharge from the aquifer system – note that one parameter alters the others.



Water management is a concern in the Western U.S., but other parts of the Nation are experiencing issues as well...



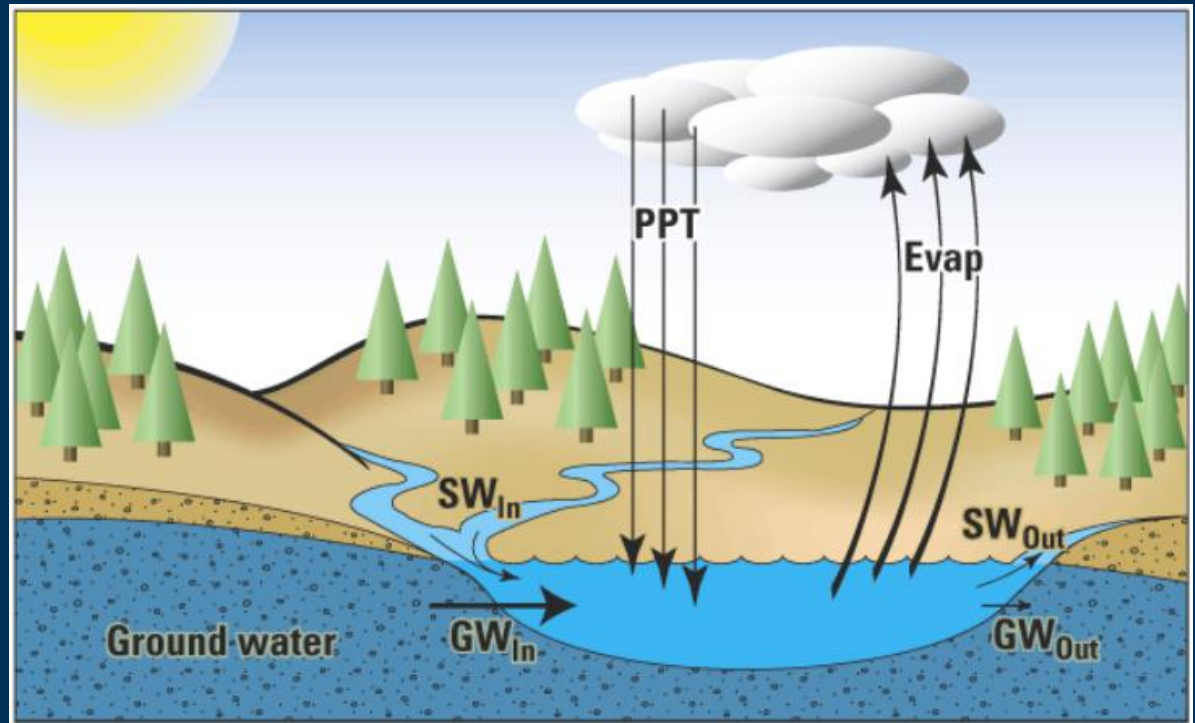
Groundwater has been the sole source of drinking water for about 8.2 million people in the Great Lakes watershed since ~1864. This long-term pumping has lowered groundwater levels by as much as 900' in the sandstone aquifer underlying the Chicago area. Concern over how such pumping affected surface water in the Great Lakes region led to the reduction of groundwater withdrawals in much of the area. Water levels are recovering in some areas, however, declines continue in others (Grannemann and others, 2000 and Alley and others, 1999).

How do you keep ahead
of water-use and water-
quality issues?

Hydrologic monitoring
networks.

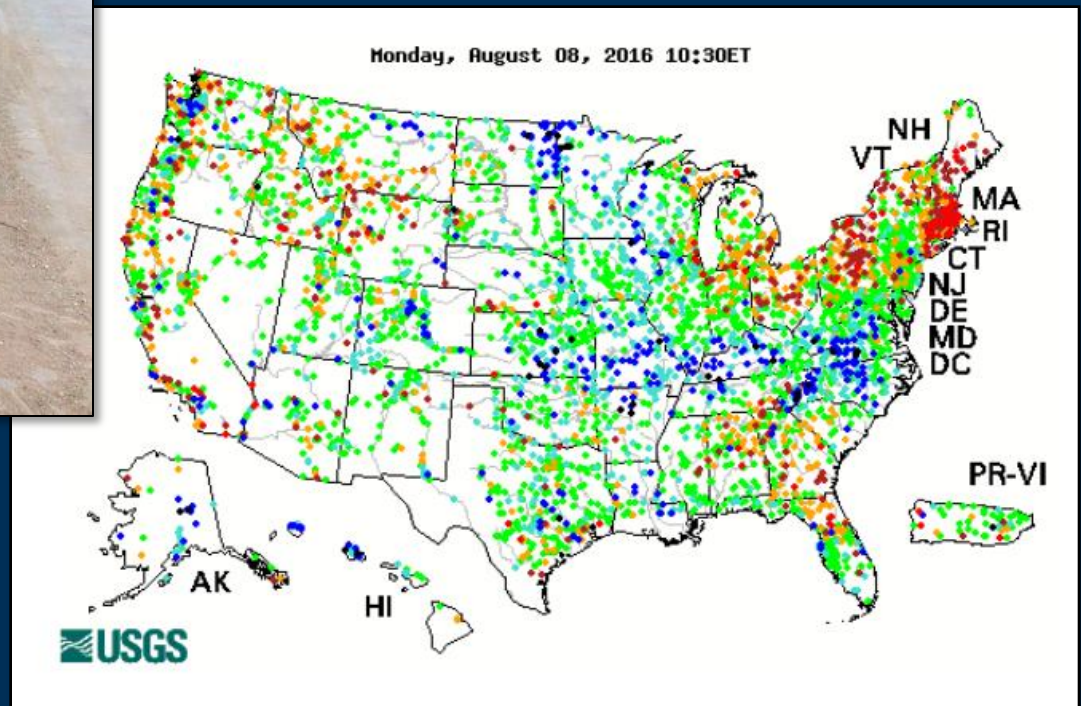
We need adequate data to solve a basic water-budget equation in KY's critical areas so we can manage water resources.

$$\text{Precipitation} = \text{Evapotranspiration (ET)} + \text{Streamflow (Q)} + \Delta \text{Groundwater (GW)} + \Delta \text{Soil Moisture (SM)} + \Delta \text{Reservoir Storage (RSV)} + \Delta \text{Diversions}$$



Streamflow - USGS Real-Time Streamgages

USGS operates approximately **15,000** sites nationally with real-time streamflow data. This national network allows local data to be quickly scaled-up to a regional or national context to assess conditions – but it may NOT be locally optimized for specific uses.

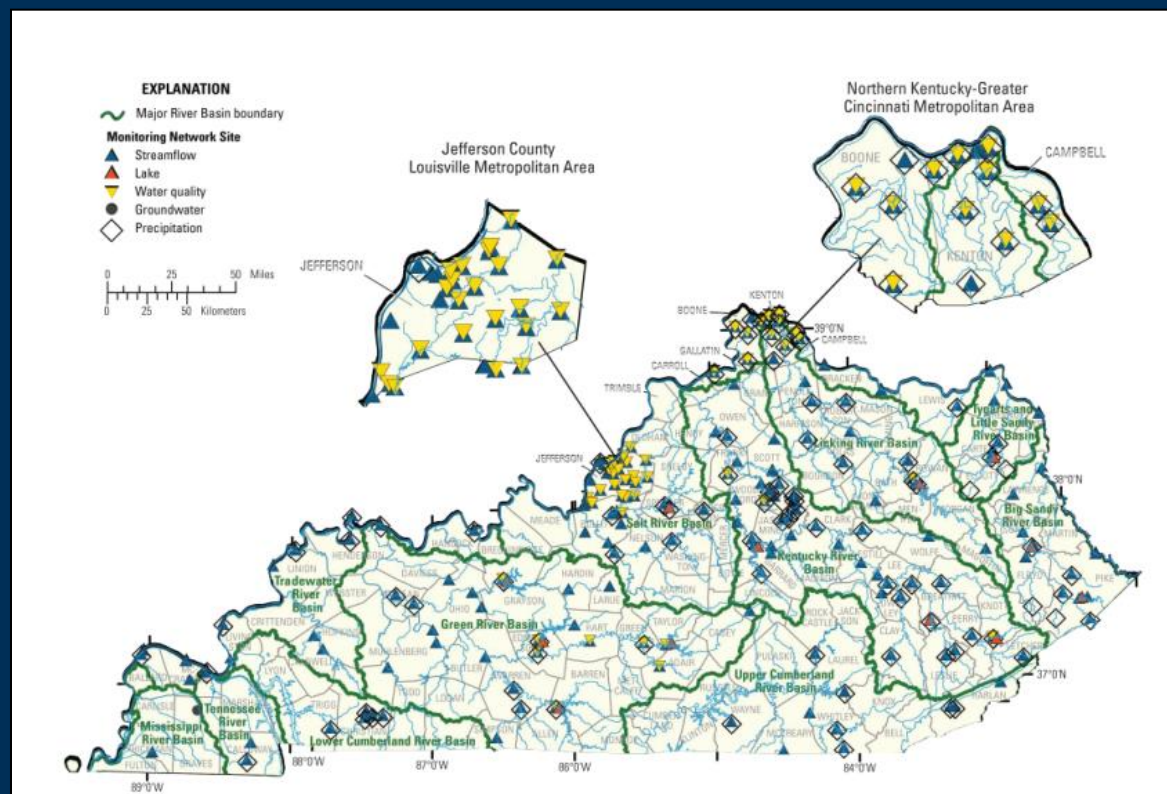


USGS IN-KY WSC has over **200** sites with real-time data in Kentucky

USGS continually assesses the statistical strength of the network; we already see a loss of statistical strength in rural areas as static funding is shifted to urban areas to address changing priorities.

Notably, gaps exist in the Western KY and the Cumberland River Basins.

Gages are also used to compute estimates of **GROUNDWATER RECHARGE** and other related water-budget parameters.



Groundwater -

KGS Making Progress Toward Improved Statewide Groundwater Monitoring and Research but there are significant gaps.

$$\text{Precipitation} = ET + \text{Streamflow} + \underline{\Delta GW} + \Delta SM + \Delta RSV + \Delta \text{Diversions}$$



Re-Establishing a Groundwater-Level Observation Network

Status of KGS Observation Well Sites As Of November 15, 2015



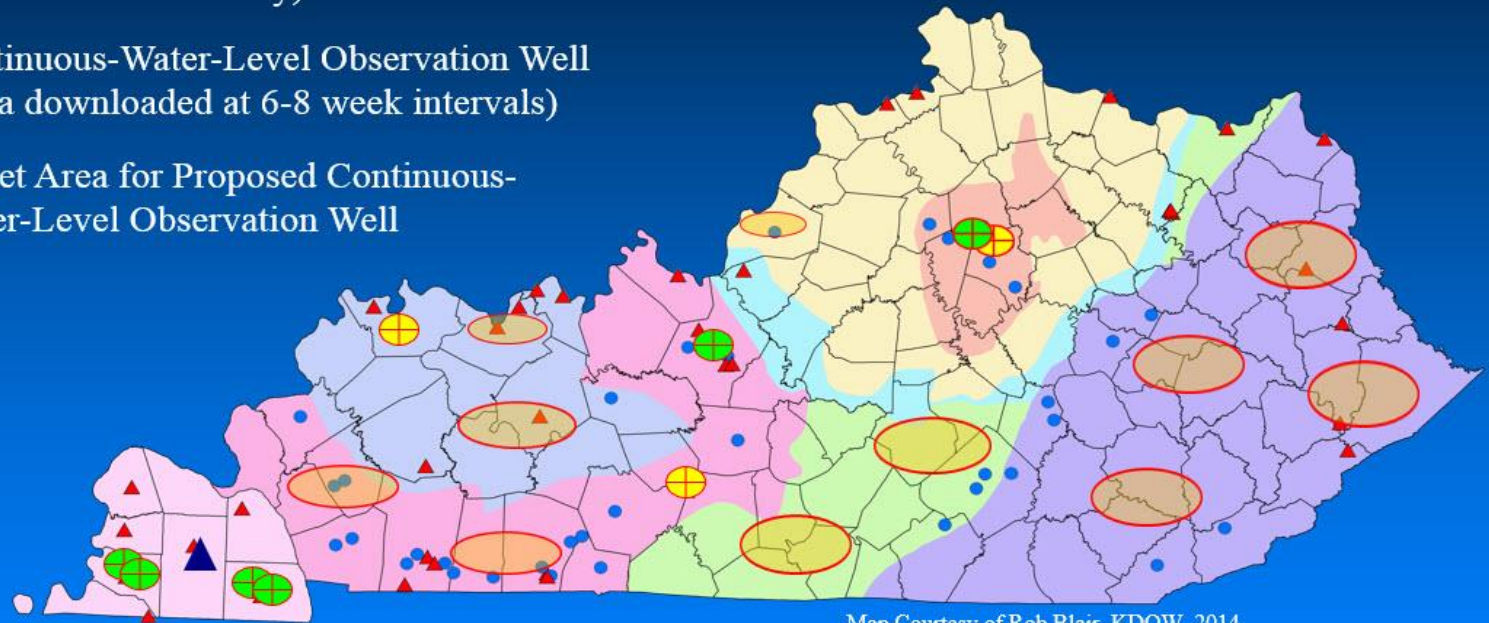
Continuous-Water-Level Observation Well
(Data downloaded daily)



Continuous-Water-Level Observation Well
(Data downloaded at 6-8 week intervals)



Target Area for Proposed Continuous-Water-Level Observation Well



Map Courtesy of Rob Blair, KDOW, 2014

Groundwater Monitoring Sites
Maintained By Other Agencies:



KDOW-ITAC Groundwater-Quality Sampling Sites

USGS National Climate-Response Network Well

Summary: KGS Activities to Improve GW Monitoring

- ✓ Began re-establishing statewide network of long-term water-level observation sites.
- ✓ Conducting focused groundwater research to better characterize the aquifer system in the Jackson Purchase Area.
- ✓ Conducting aquifer tests to enable better assessment of groundwater availability.
- ✓ Creating new webpages needed to enhance public access to groundwater data.
- ✓ Conducting targeted sub-regional groundwater-quality assessments.



Campton, Wolfe Co.
New Plant Well (Brewer Trail Road)
December 19, 2009

BACKGROUND
The City of Campton had been looking for an additional groundwater supply well to supplement water production drawn from nearby Campton Lake. KGS was asked in 2006 to assist in performing aquifer tests on three wells: one by the old water plant, one at the city's lift station on Swift Road, and one at the location where the new water plant is now located on Brewer Trail Road.

Site of well near location of proposed Campton Water Plant.

Well sites on a 7.5-minute topograph base of the Campton quadrangle.

Flow is determined by a gallon counter and discharged to a nearby creek.

Aquifer test setup conducted using drill rig.

Page 1

Mesonet – Climate and soil-moisture data



$$\underline{Precipitation} = ET + Streamflow + \Delta GW + \underline{\Delta SM} + \Delta RSV + \Delta Diversions$$

Water quality



There are many issues related to water quality.
Harmful Algal Blooms (HABs) is among the most recent but there is the Gulf Hypoxic Zone and many other issues.

The image shows a screenshot of the United States Environmental Protection Agency (EPA) website. The main page is titled "Harmful Algal Blooms" under the "Nutrient Pollution" section. The page includes a sidebar with links to "Nutrient Pollution", "The Problem", "Sources and Solutions", "The Effects", "Where This Occurs", "What You Can Do", and "Policy and Data". The main content area starts with "You are here: EPA Home » Nutrient Pollution » Harmful Algal Blooms" and a heading "Harmful Algal Blooms". Below this, it states: "Harmful algal blooms are a major environmental problem... green algae or cyanobacteria, harmful algal blooms can harm ecosystems and the economy." Two callout boxes are overlaid on the page. The first callout box, titled "What causes harmful algal blooms?", lists: "Harmful algal blooms need: • Sunlight • Slow-moving water • Nutrients (nitrogen and phosphorus)". It also states: "Nutrient pollution from human activities makes leading to more severe blooms that occur more frequently." and includes a link: "Learn where nutrient pollution comes from". The second callout box, titled "Sources and Solutions", lists: "Excessive nitrogen and phosphorus that washes into water bodies and is released into the air are often the direct result of human activities. The primary sources of nutrient pollution are: • **Agriculture:** Animal manure, excess fertilizer applied to crops and fields, and soil erosion make agriculture one of the largest sources of nitrogen and phosphorus pollution in the country. • **Stormwater:** When precipitation falls on our cities and towns, it runs across hard surfaces - like rooftops, sidewalks and roads - and carries pollutants, including".

EPA United States Environmental Protection Agency

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Nutrient Pollution

You are here: EPA Home » Nutrient Pollution » Harmful Algal Blooms

Harmful Algal Blooms

Harmful algal blooms are a major environmental problem... green algae or cyanobacteria, harmful algal blooms can harm ecosystems and the economy.

What causes harmful algal blooms?

Harmful algal blooms need:

- Sunlight
- Slow-moving water
- Nutrients (nitrogen and phosphorus)

Nutrient pollution from human activities makes leading to more severe blooms that occur more frequently.

[Learn where nutrient pollution comes from](#)

Nutrient Pollution

The Problem

Sources and Solutions

The Effects

Where This Occurs

What You Can Do

Policy and Data

Sources and Solutions

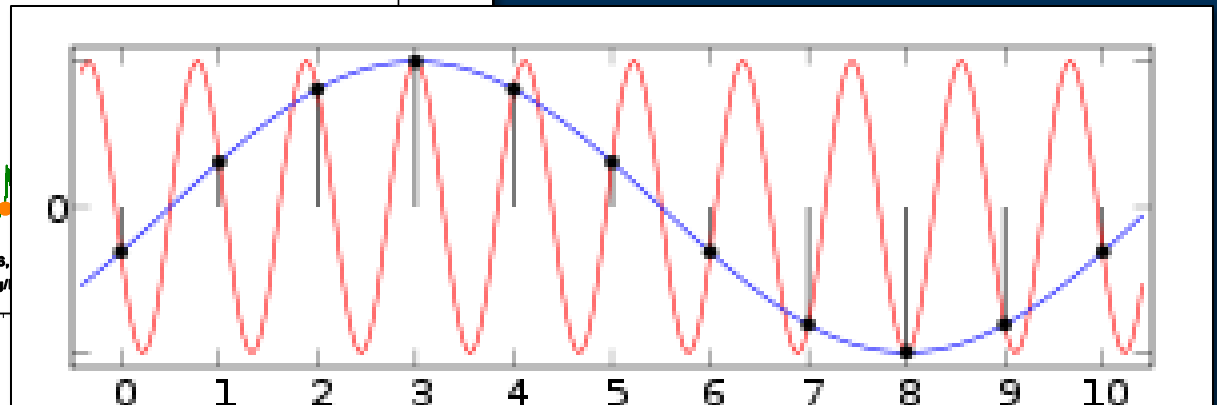
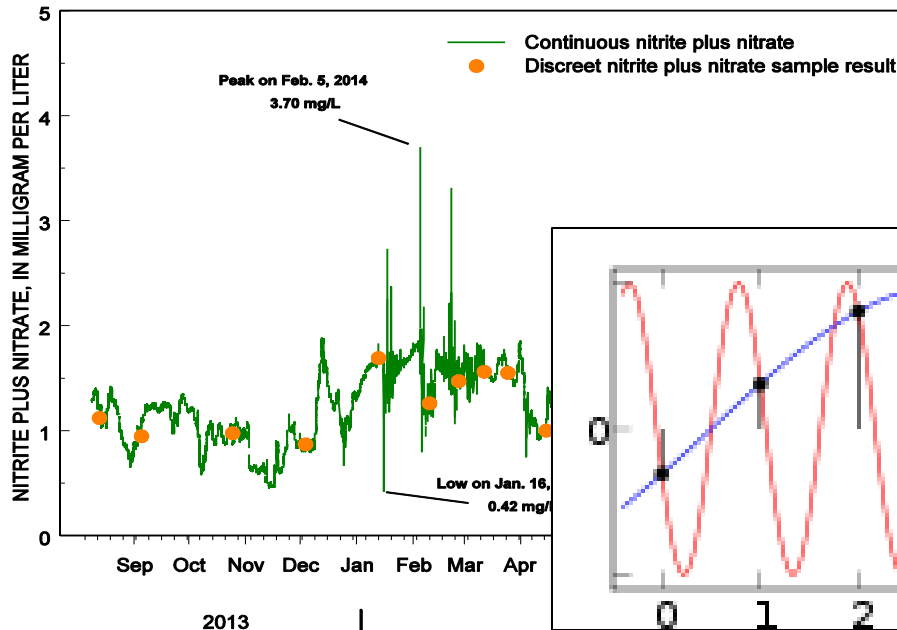
You are here: EPA Home » Nutrient Pollution » Sources and Solutions

Excessive nitrogen and phosphorus that washes into water bodies and is released into the air are often the direct result of human activities. The primary sources of nutrient pollution are:

- **Agriculture:** Animal manure, excess fertilizer applied to crops and fields, and soil erosion make agriculture one of the largest sources of nitrogen and phosphorus pollution in the country.
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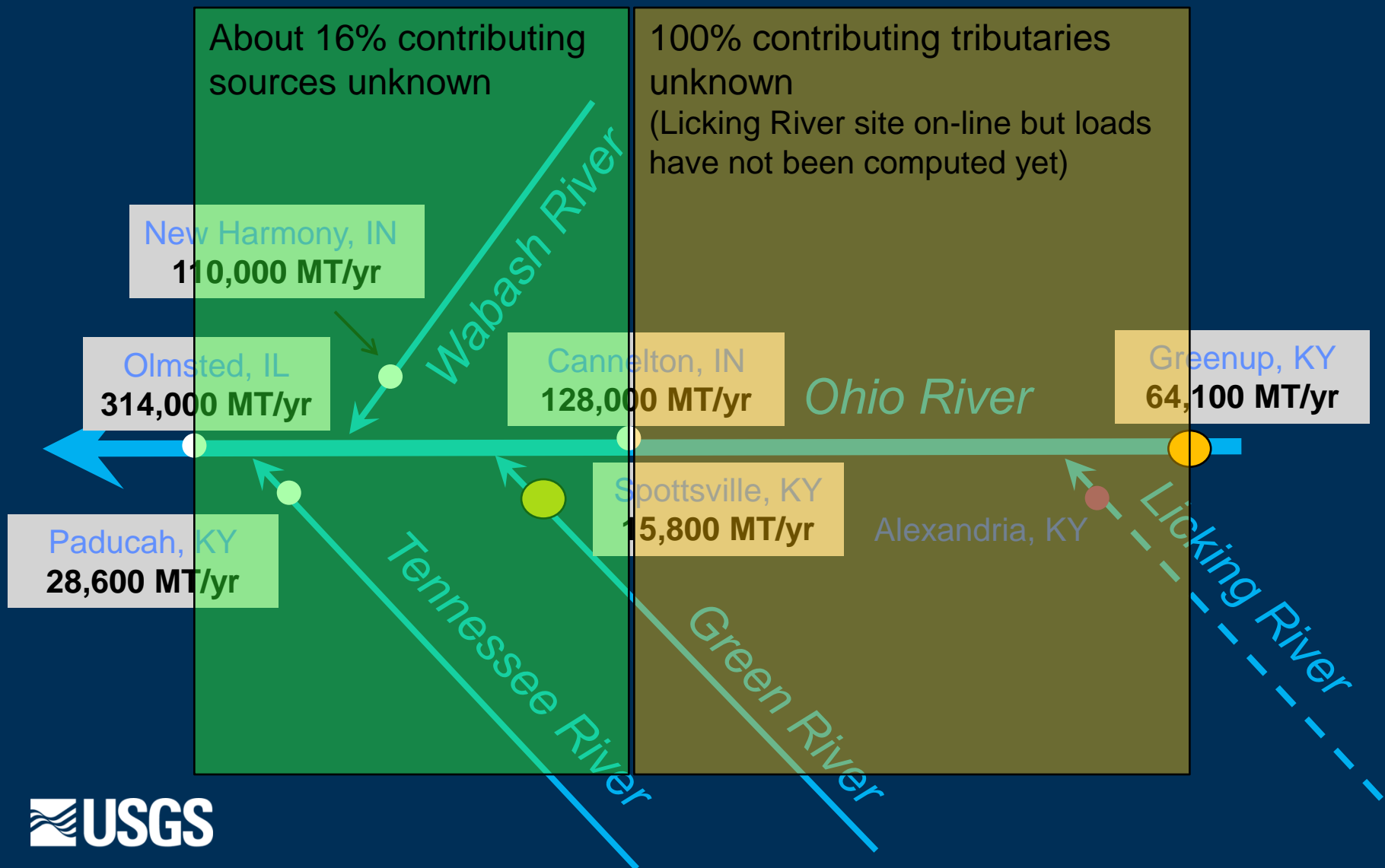
With issues such as HABs and Gulf Hypoxia, we need defensible science to know (among other things):

1) What are the causes / effects of water-quality issues?
Here, real-time continuous data is critical to determining these.



2) What's coming into Kentucky and what's going out?

Estimates of nitrite plus nitrate ANNUAL loads

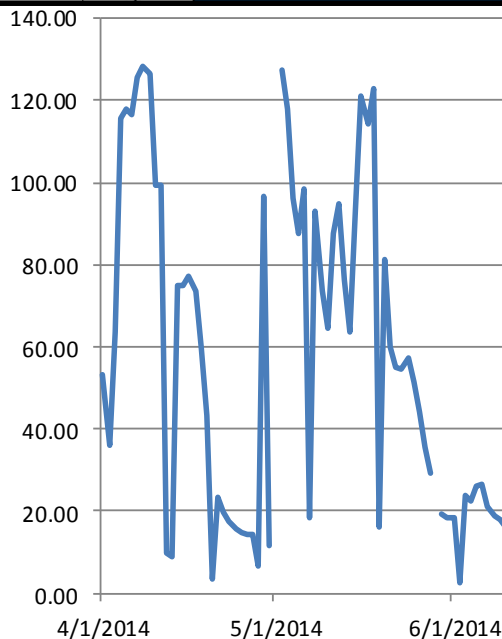
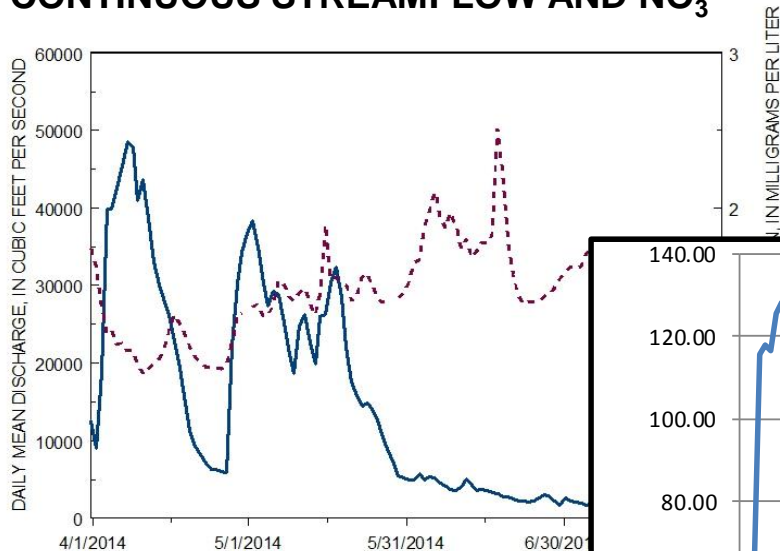


Real-time continuous nitrate data

Green River at Spottsville, KY

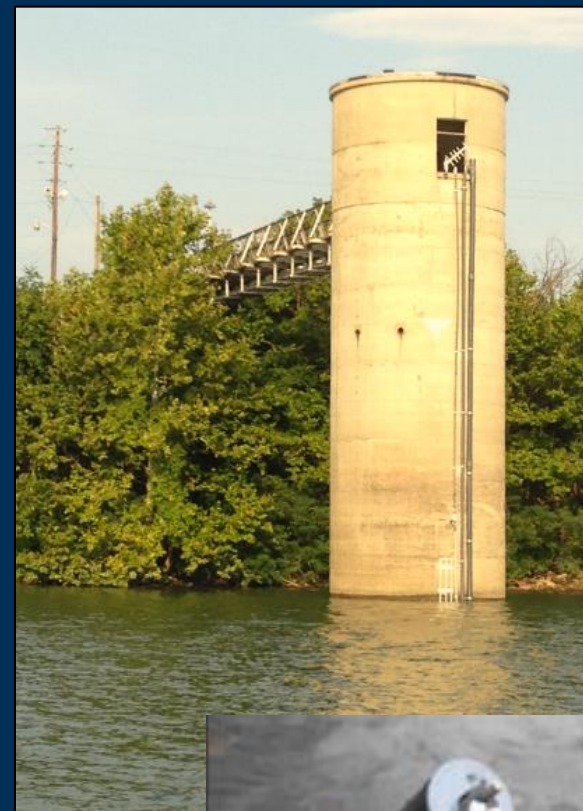
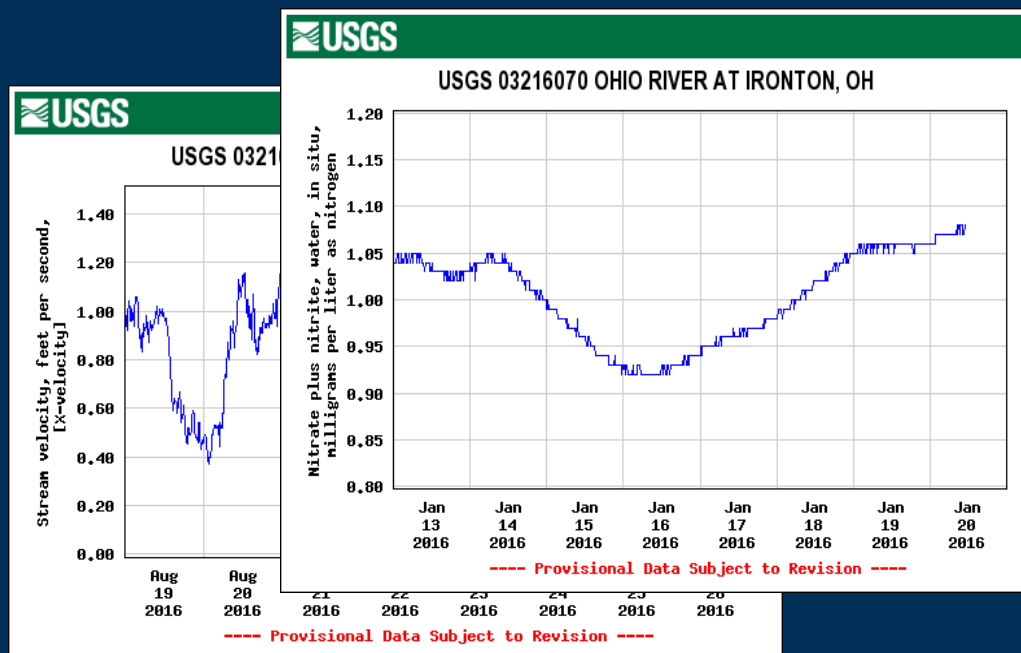
Daily Load = much greater information about what's happening in the basin

CONTINUOUS STREAMFLOW AND NO₃



USGS “Super Gage” – what is it?

Ohio River at Ironton, OH



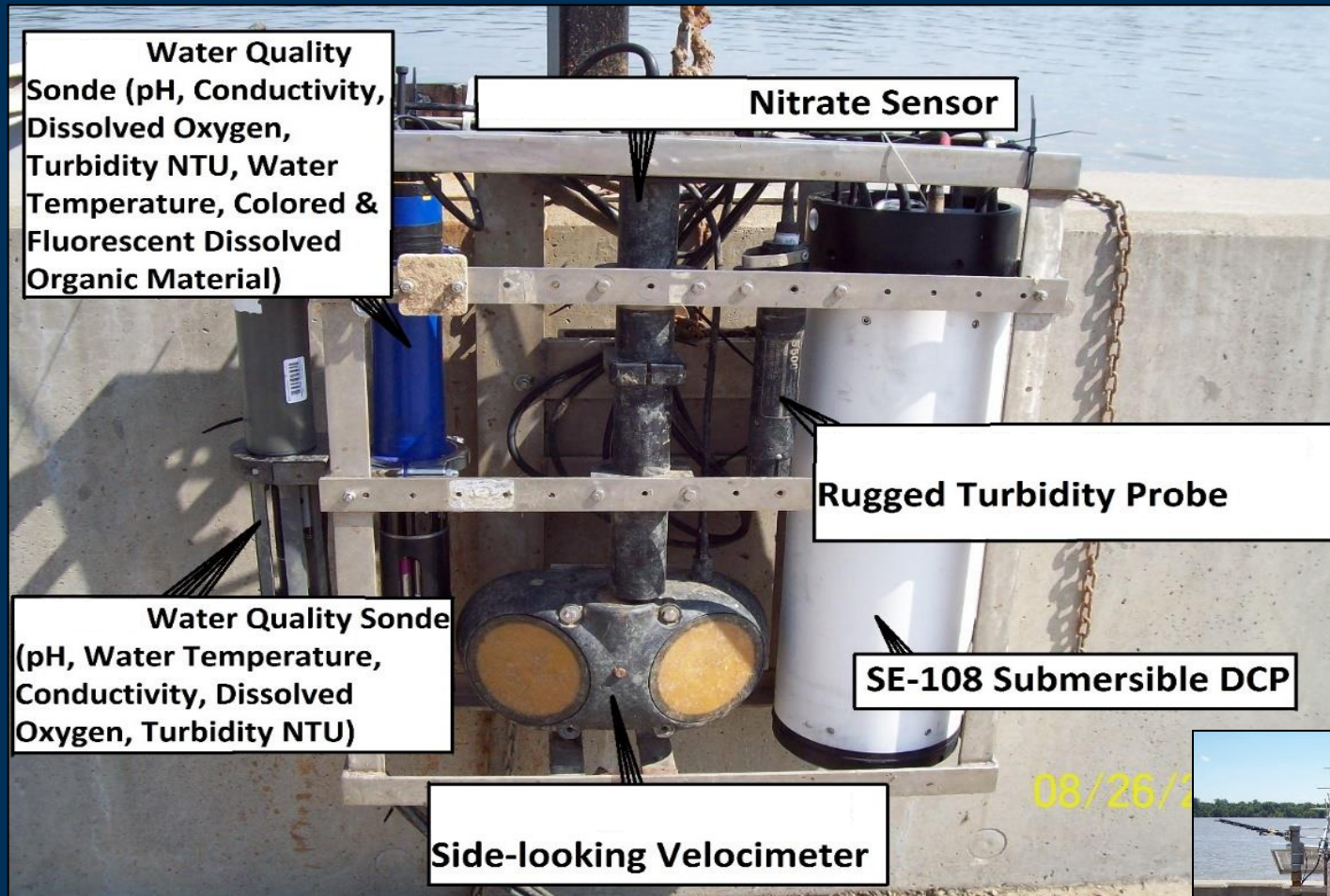
USGS Super Gages

- Extensive equipment and real-time telemetry
- Continuous “real-world” data
- Data ties models to reality and improves accuracy
- QA/QC = defensible data



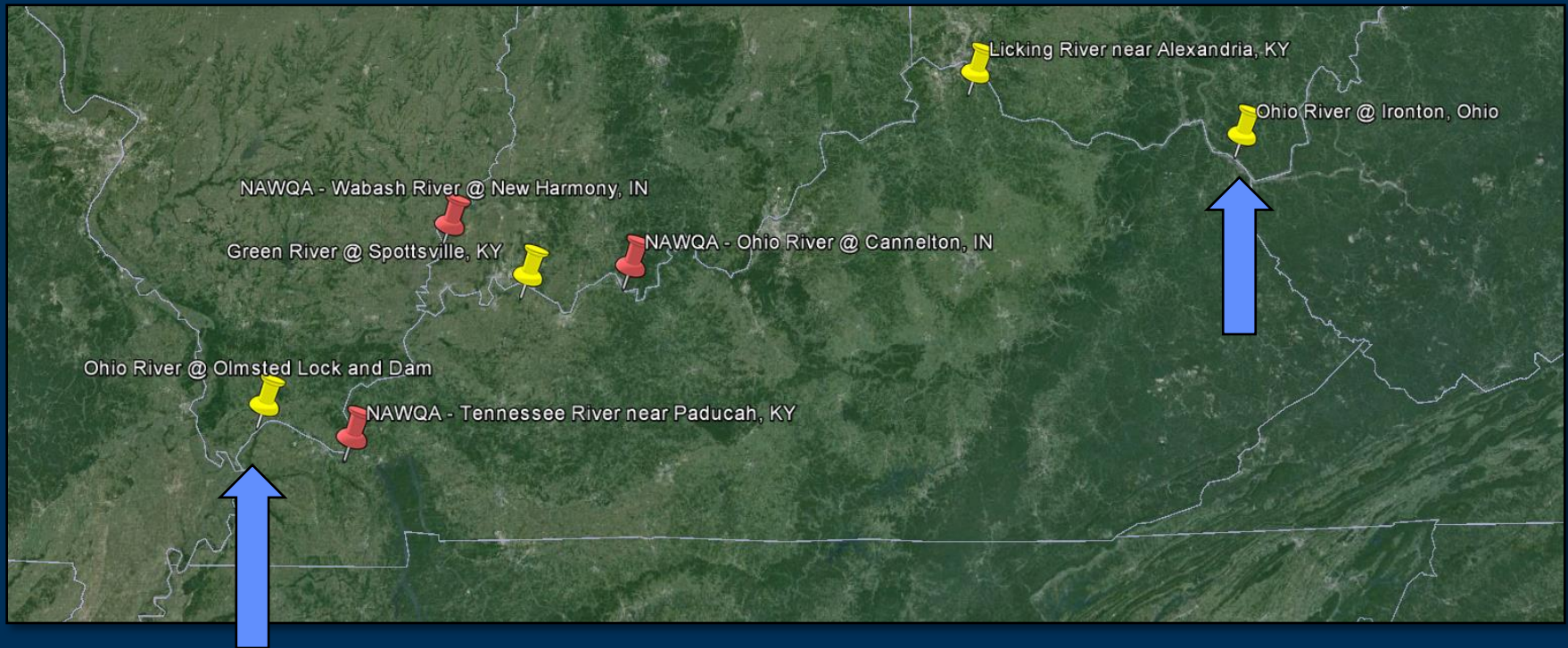
USGS Super Gage

Ohio River at Olmsted Lock and Dam



Current USGS Super Gage Locations

Incoming

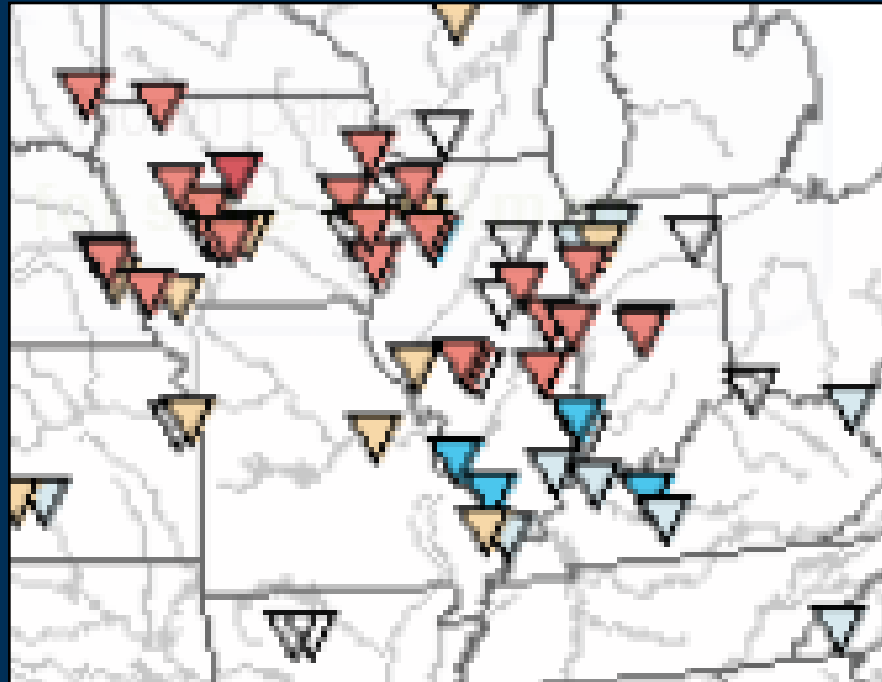
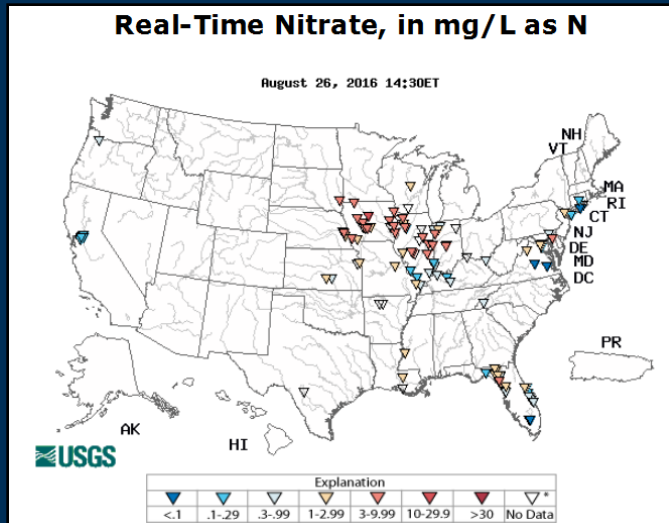


Outgoing



Yellow – Real-time USGS Super Gage
Red – USGS long-term NAWQA sampling sites

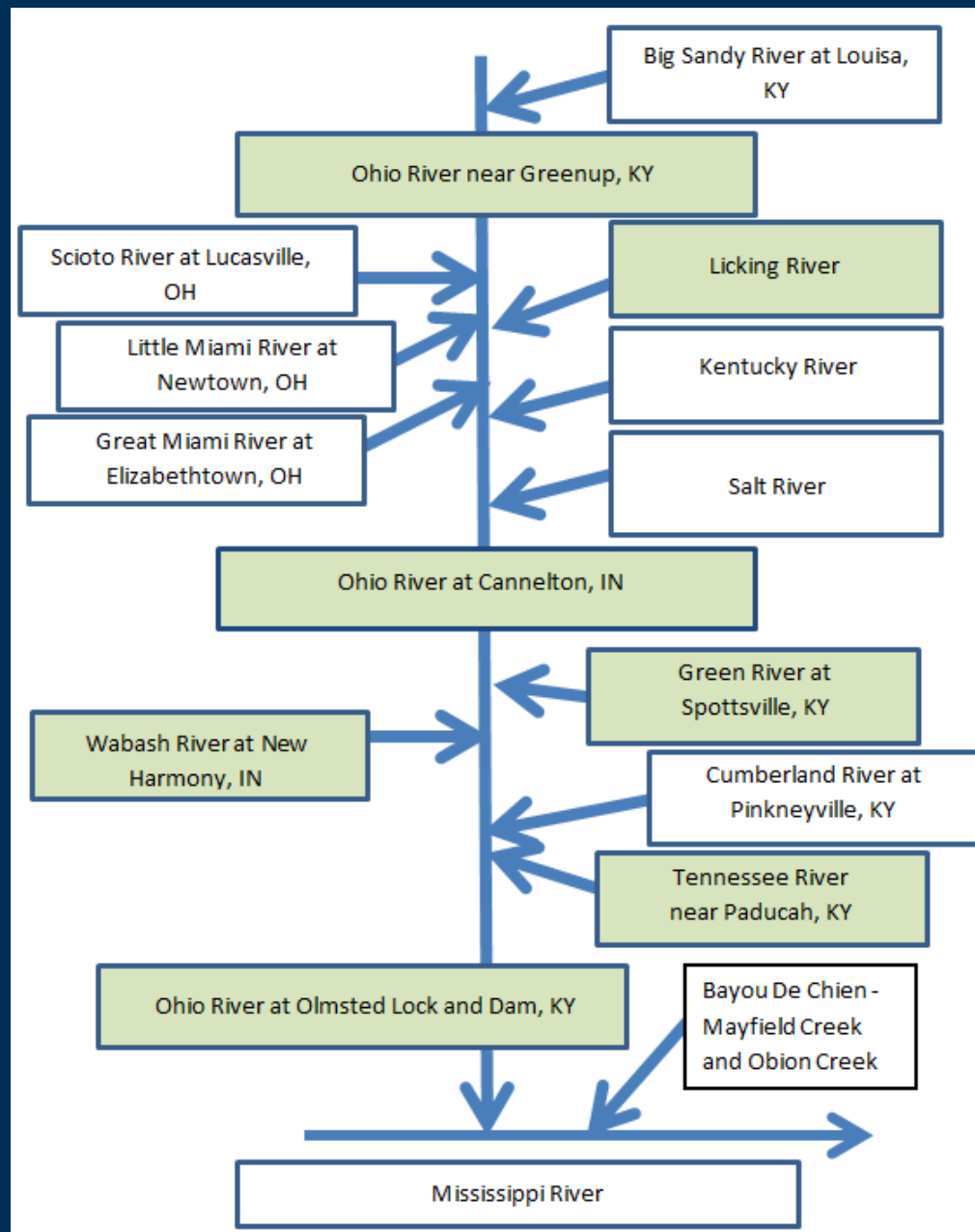
National Perspective – with real-time monitoring (8/26/2016)



Future needs

- * Sites on all major river basins

- * Sustainable funding



Questions?

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